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Tsen et al.

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(54) **SCANNER OVERLAY CORRECTION SYSTEM AND METHOD**

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H01L 21/66 (2006.01)
H01L 21/67 (2006.01)

(52) **U.S. Cl.**

CPC ***H01L 22/12*** (2013.01); ***H01L 21/67063*** (2013.01); ***H01L 21/67092*** (2013.01)

(58) **Field of Classification Search**

CPC H01L 21/67063; H01L 21/67092; H01L 22/12

See application file for complete search history.

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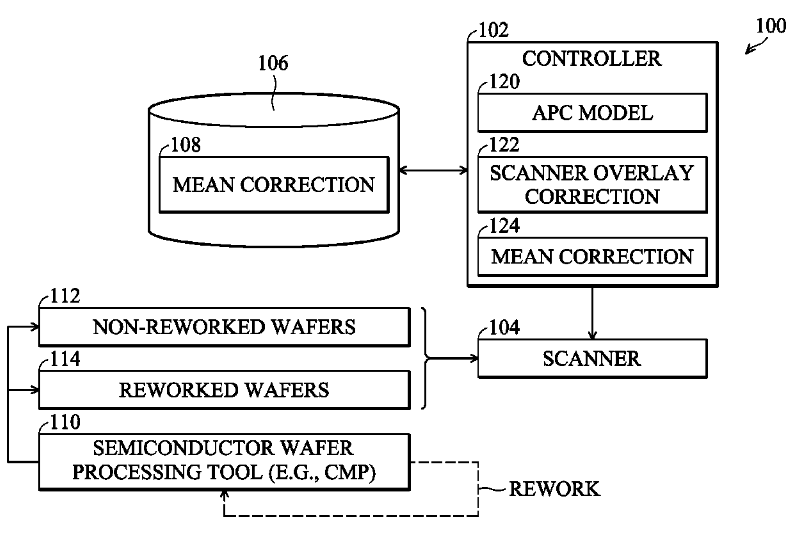
(57) **ABSTRACT**

A method includes performing a semiconductor fabrication process on a plurality of substrates. The plurality of substrates are divided into a first subset and a second subset. A rework process is performed on the second subset of the plurality of substrates but not on the first subset. A respective mean value of at least one exposure parameter for a lithography process is computed for each respective one of the first and second subsets of the plurality of substrates. A scanner overlay correction and a mean correction are applied to expose a second plurality of substrates on which the rework process has been performed. The mean correction is based on the computed mean values.

20 Claims, 7 Drawing Sheets



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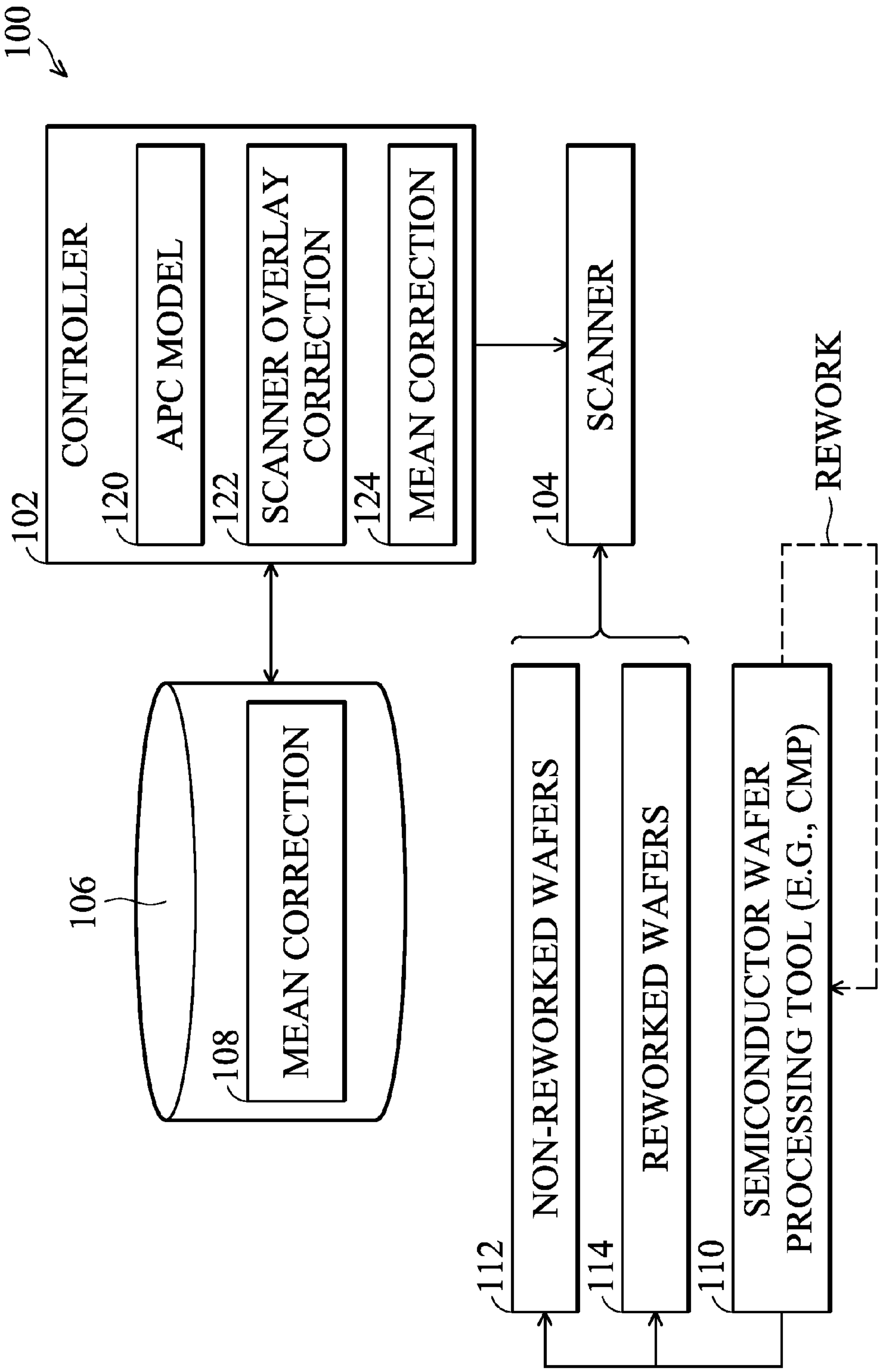
100
102
CONTROLLER
120
APC MODEL
122
SCANNER OVERLAY CORRECTION
124
MEAN CORRECTION
104
SCANNER
106
108
MEAN CORRECTION
112
NON-REWORKED WAFERS
114
REWORKED WAFERS
110
SEMICONDUCTOR WAFER PROCESSING TOOL (E.G., CMP)
REWORK

FIG. 1

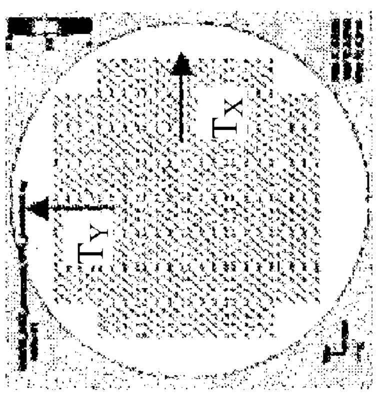

FIG. 2A

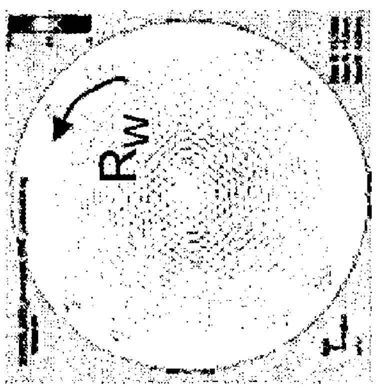

FIG. 2B

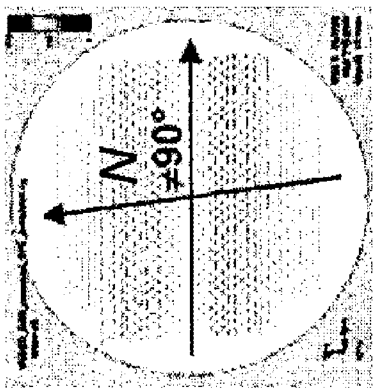

FIG. 2C

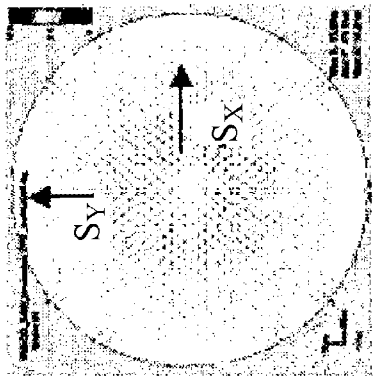

FIG. 2D

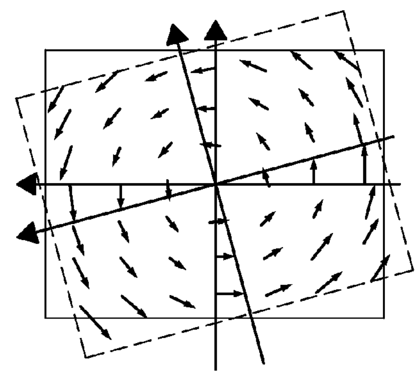
R_S

FIG. 2E

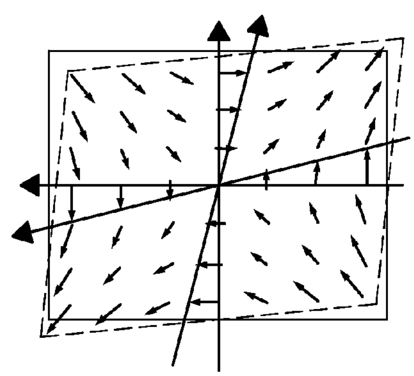
R_A

FIG. 2F

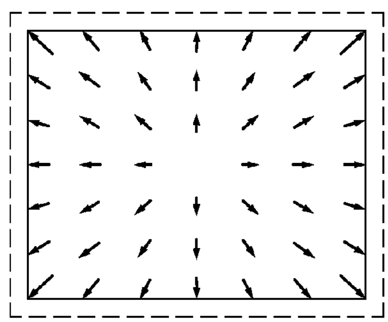
M_S

FIG. 2G

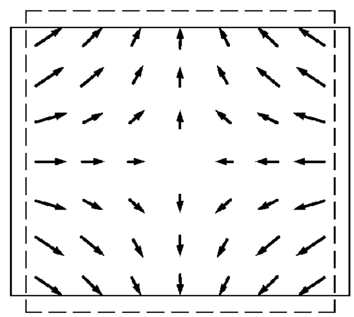
M_A

FIG. 2H

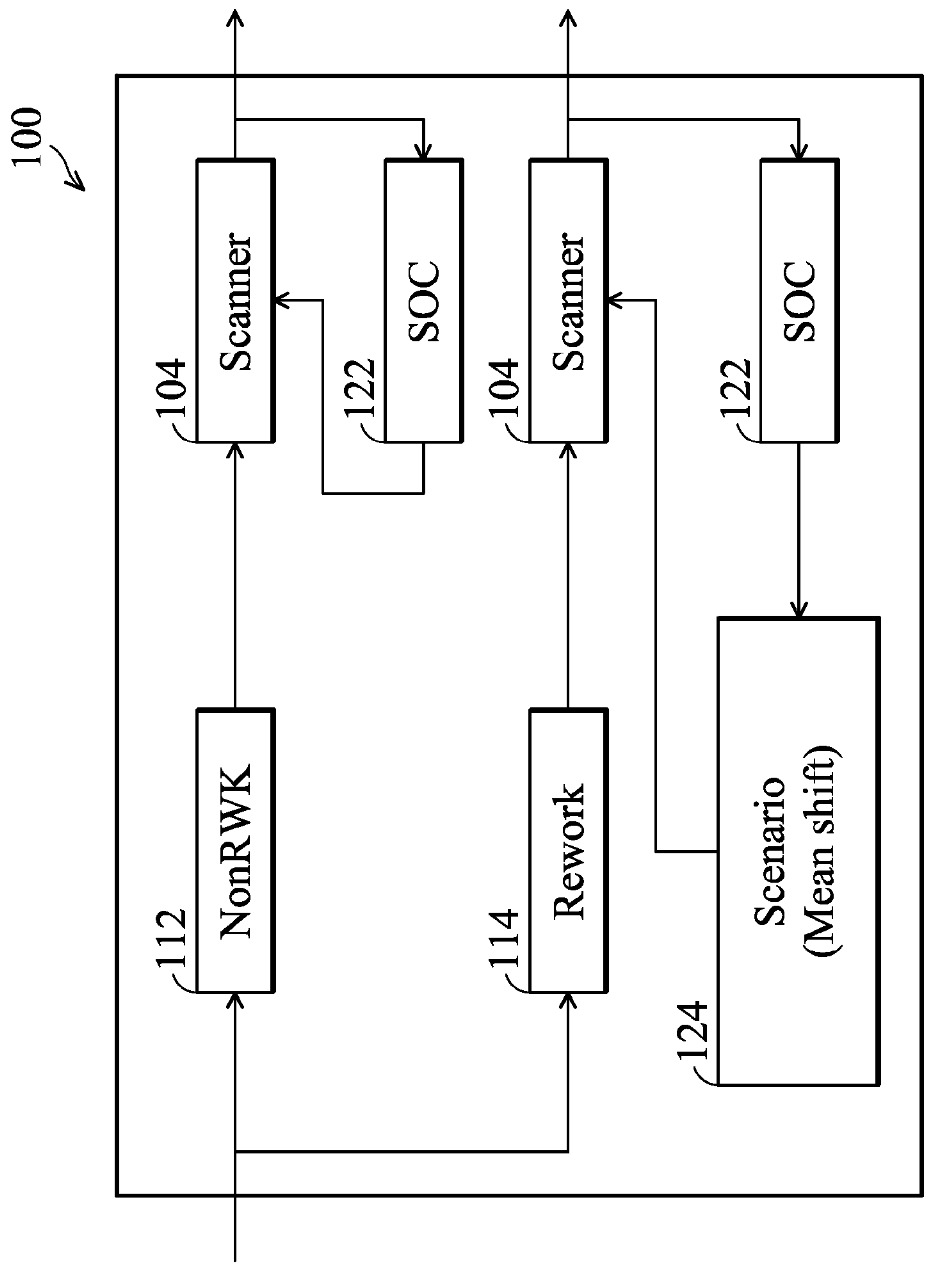
100
104
Scanner
122
SOC
104
Scanner
122
SOC
112
NonRWK
114
Rework
124
Scenario
(Mean shift)

FIG. 3

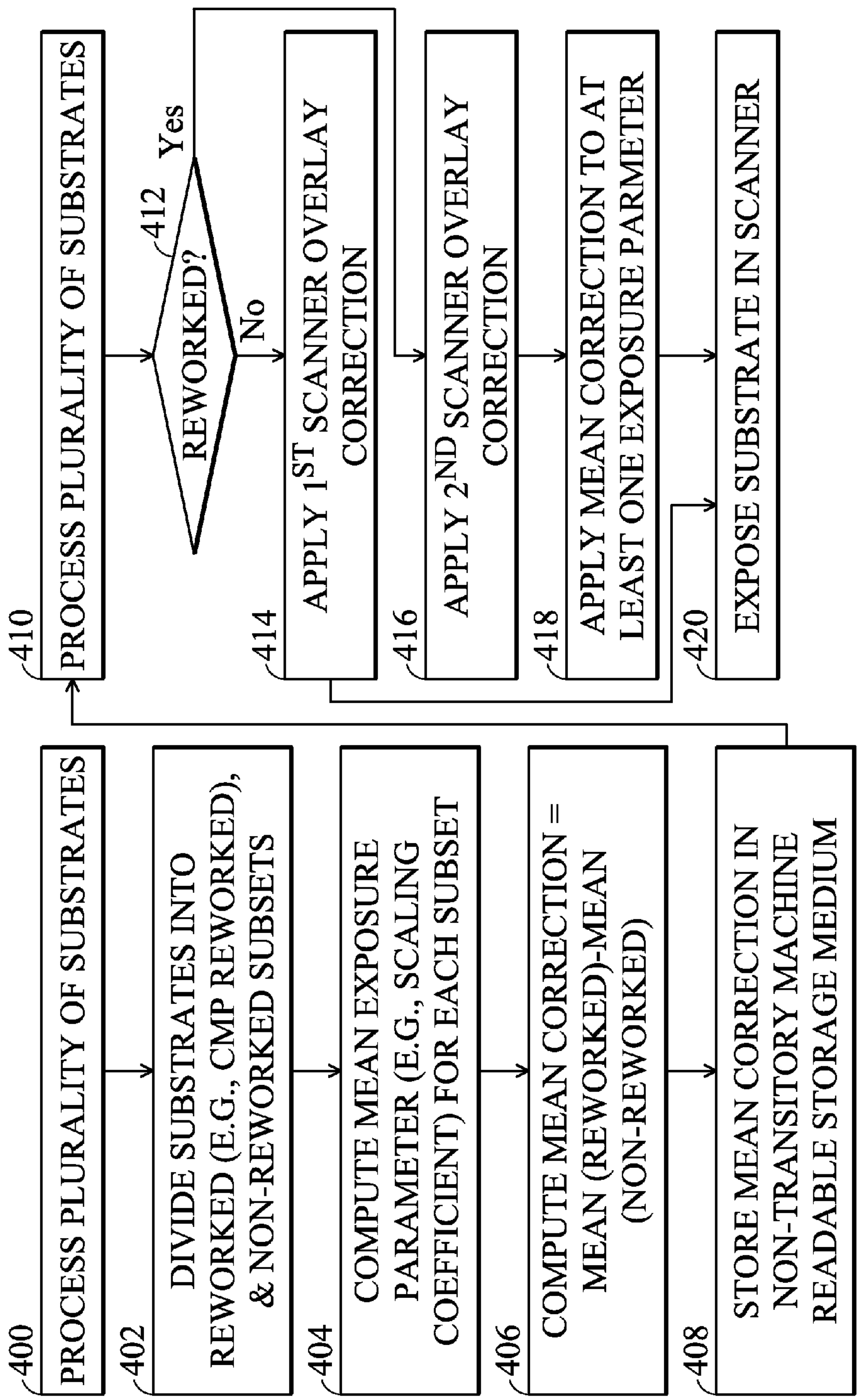
400
PROCESS PLURALITY OF SUBSTRATES
402
DIVIDE SUBSTRATES INTO REWORKED (E.G., CMP REWORKED), & NON-REWORKED SUBSETS
404
COMPUTE MEAN EXPOSURE PARAMETER (E.G., SCALING COEFFICIENT) FOR EACH SUBSET
406
COMPUTE MEAN CORRECTION = MEAN (REWORKED)-MEAN (NON-REWORKED)
408
STORE MEAN CORRECTION IN NON-TRANSITORY MACHINE READABLE STORAGE MEDIUM
410
PROCESS PLURALITY OF SUBSTRATES
412
REWORKED?
Yes
No
414
APPLY 1ST SCANNER OVERLAY CORRECTION
416
APPLY 2ND SCANNER OVERLAY CORRECTION
418
APPLY MEAN CORRECTION TO AT LEAST ONE EXPOSURE PARMETER
420
EXPOSE SUBSTRATE IN SCANNER

FIG. 4

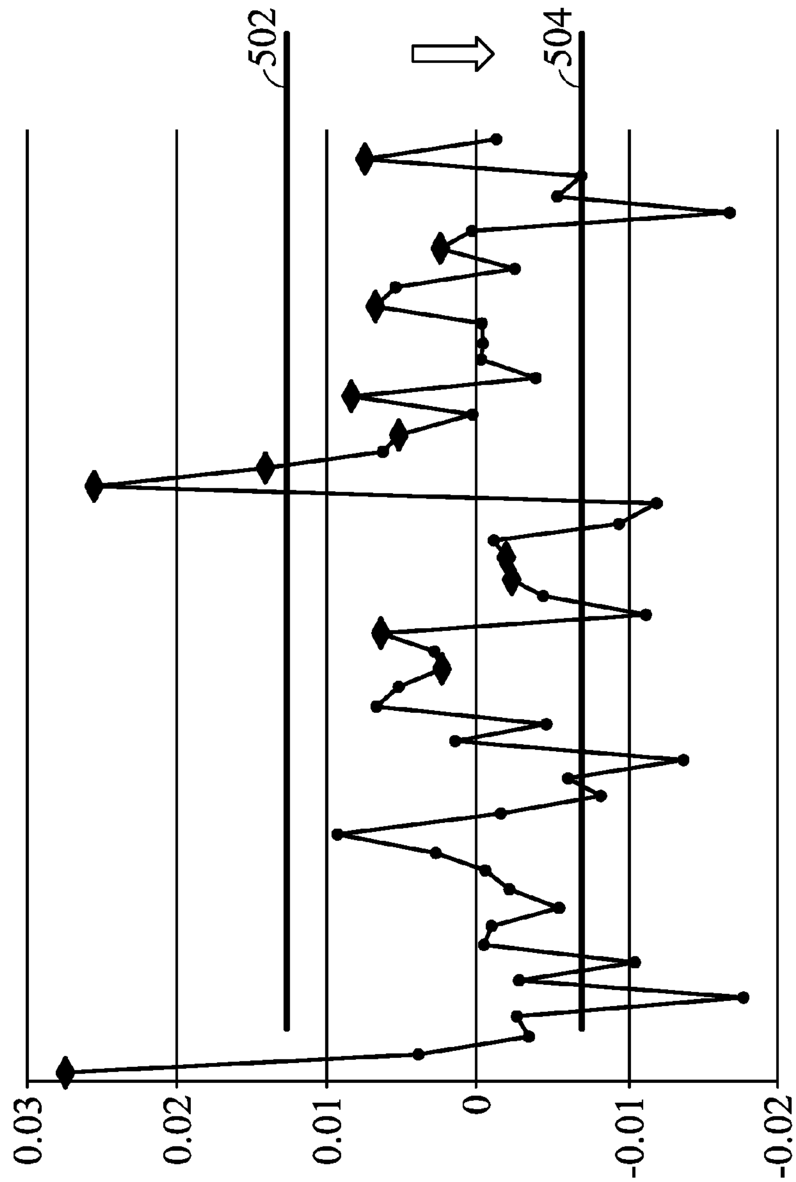

FIG. 5

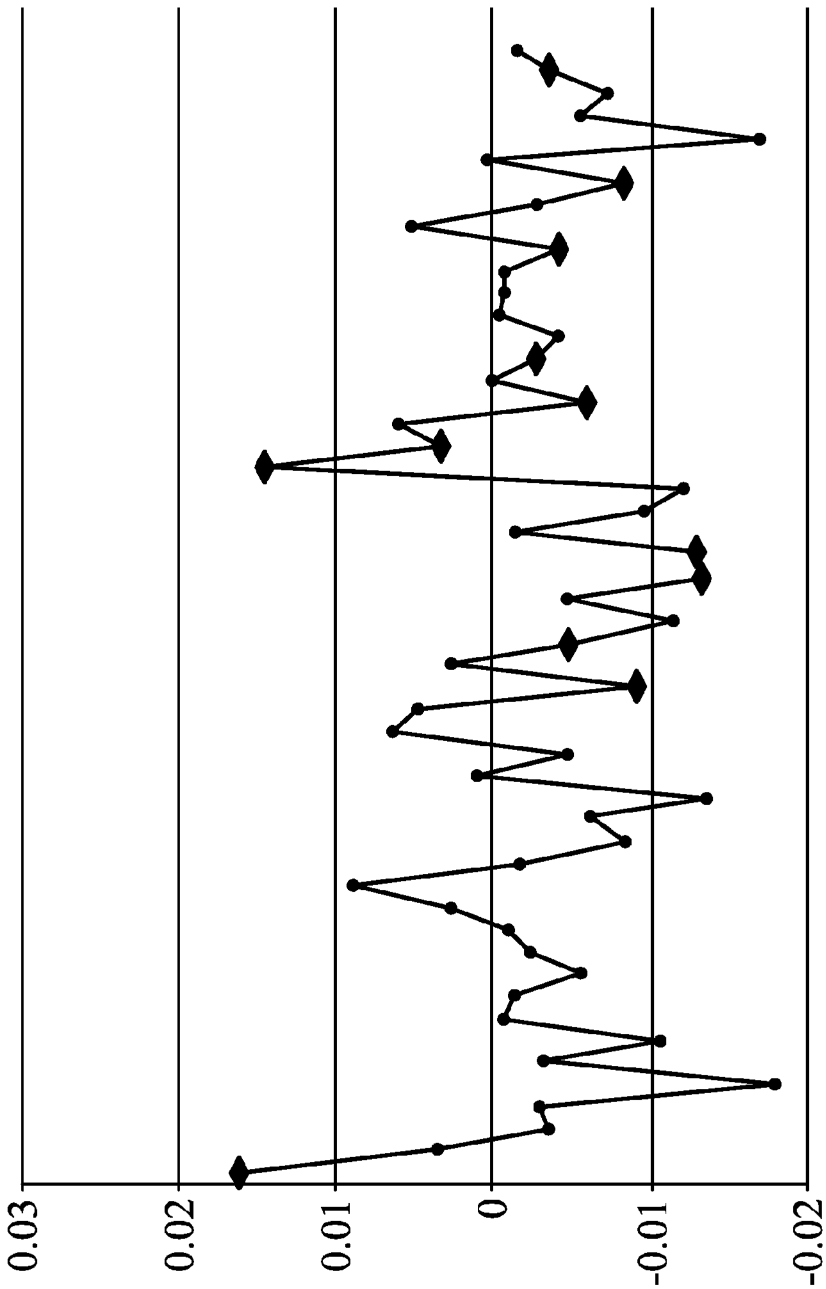

FIG. 6

SCANNER OVERLAY CORRECTION SYSTEM AND METHOD

This application is a division of U.S. patent application Ser. No. 13/716,340, filed Dec. 17, 2012, which is expressly incorporated by reference herein in its entirety.

FIELD

This disclosure relates generally to semiconductor processing and more specifically to scanner equipment used in photolithography.

BACKGROUND

Lithography is widely used in integrated circuit (IC) fabrication. A material layer is deposited on a wafer. A masking material is formed over the material layer and exposed in a pattern to form a hard mask for etching. Portions of the material layer which are not covered by the mask are then etched to form one or more patterns (e.g., trenches) that are filled with conductive material (e.g., copper) and planarized to form circuit paths. Another material layer is deposited over the patterned first material layer and the process is repeated to pattern the second layer. This process is repeated many times.

To ensure proper connectivity and performance, the patterns in adjacent layers are aligned properly with each other. Alignment marks (e.g., boxes) are used to align each added layer to the previously formed layer.

To maintain proper alignment between layers, a form of run-to-run control referred to as advance process control (APC) is used. Alignment errors are monitored. From time to time, an operator inputs a correction (e.g., a translation, rotation or scaling correction) to the scanning exposure tool, perhaps weekly or monthly. This correction is applied to compensate for the condition causing the misalignment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system for controlling a scanner.

FIGS. **2**A-**2**D are diagrams showing the parameters of an exemplary inter-field overlay model.

FIGS. **2**E-**2**H are diagrams showing the parameters of an exemplary intra-field overlay model.

FIG. **3** is a schematic diagram of the APC controller of FIG. **1**

FIG. **4** is a flow chart of a method for controlling the scanner of FIG. **1**.

FIG. **5** is a diagram of overlay error data without a mean correction.

FIG. **6** is a diagram of overlay error data with a mean correction for reworked wafers.

DETAILED DESCRIPTION

This description of the exemplary embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description.

FIG. **1** is a schematic block diagram of an example of a system **100**. A photo tool **104** is provided for performing photolithographic exposure. In some embodiments, the photo tool **104** is a stepper. A stepper passes light through a mask or reticle, forming an image of the reticle pattern. The image is focused and reduced by a lens, and projected onto the surface of a semiconductor substrate that is coated with a photoresist.

The stepper translates or "steps" the wafer from one field or shot location to another, by moving the wafer back and forth under the lens of the stepper.

In some embodiments, the photo tool **104** is a scanner. Scanners are steppers that move the reticle stage and wafer stage in opposite directions relative to each other during the exposure. Instead of exposing the entire field at once, the exposure is made through an aperture that is as wide as the exposure field, but only a fraction of its length. The image from the aperture is scanned across the exposure area. Although reference is made below to an example of a scanner, the techniques described below with reference to scanner **104** can also be applied to other types of steppers.

A controller **102** controls operation of the scanner. The controller **102** includes an advanced process control (APC) model **120**, a scanner overlay correction module **122** and a mean correction module **124**. In some embodiments, the controller **102** comprises a general purpose processor programmed to perform the computations described herein. The general purpose processor can be a computer or an embedded processor or microcontroller. In some embodiments, the controller comprises application specific integrated circuitry (ASIC) for performing the functions described herein.

The controller **102** has read and write access to a non-transitory, machine readable storage medium **106** which has been encoded to store one or more mean correction values to be used for applying respective offset(s) to one or more exposure parameters used by the scanner **104**.

In some embodiments, the controller contains a scanner overlay correction module **122** corresponding to the scanner. The scanner overlay correction module includes an adjustment for wafer rotation, an adjustment for wafer non-orthogonality and an adjustment for wafer scaling coefficients. In other embodiments, other exposure parameters are used, such as one or more of the group consisting of wafer rotation, wafer non-orthogonality and wafer scaling coefficients.

The mean correction module **124** of controller **102** is configured to determine whether a semiconductor substrate to be exposed by a scanner has been subjected to a specific process or step, such as a rework process. In some embodiments, the mean correction module **124** identifies substrates as belonging to either a first group **112** that has undergone a first set of fabrication processes, or a second group **114** that has undergone a second set of fabrication processes differing in some respect from the first set of fabrication processes.

A non-transitory, machine readable storage medium **108** contains a mean correction value to be applied to the scanner for exposing the semiconductor substrate if the semiconductor substrate has been subjected to the rework process. The mean correction module **124** applies the mean correction value(s) **108** when controlling the scanner **104** to expose the substrates in the second group **114**, but not when controlling the scanner **104** to expose the substrates in the first group **112**.

The system further comprises one or more semiconductor fabrication tools **110**, such as a CMP tool. The tool(s) **110** provide a first plurality of wafers belonging to the first group **112** and a second plurality of wafers belonging to the second group **114**. For example, in some embodiments, the tool **110** is a CMP tool. Wafers in the first group **112** are planarized by the tool **110** and pass inspection without undergoing rework. Wafers in the second group **114** do not immediately pass all acceptance criteria, and are thus subjected to a CMP rework process.

The mean correction module **124** of controller **102** is configured to control the scanner **104** using a scanner overlay correction. The controller is further configured to apply the mean correction value to adjust an exposure parameter of the scanner if the semiconductor substrate to be exposed by the scanner has been subjected to the rework process. The controller is configured to control the scanner to expose substrates, on which the rework process has not been performed, without using the mean correction.

In some embodiments, the mean correction module **124** of the controller **102** is configured to compute the mean correction as a difference between: a mean of the exposure parameter among a first plurality of substrates that have been processed by the semiconductor fabrication process and the rework process, and a mean of the exposure parameter among a second plurality of substrates that have been processed by the semiconductor fabrication process but not the rework process.

The inventors have determined that subjecting a substrate to a rework process can physically alter a characteristic (e.g., thickness) of the substrate which is relevant to the APC model. Thus, in some embodiments, the controller **102** controls the scanner **104** to apply an additional correction to the second group of substrates **114**. In some embodiments, this correction is uniformly applied as a constant adjustment across all the substrates in the second group **114**. This additional correction is not applied to the substrates in the first group **112**.

In some embodiments, the semiconductor fabrication process is a chemical mechanical polishing (CMP) process performed on a layer of one of the first plurality of substrates, and the rework process is a CMP rework process performed on the same layer of the one substrate. In some embodiments, the exposure parameter includes: a first wafer scaling coefficient S_X for a first direction; and a second wafer scaling coefficient S_Y for a second direction orthogonal to the first direction.

Each scanner has an APC model **120**, which can be defined by the manufacturer of the scanner. FIGS. **2**A to **2**H show a plurality of conditions that are included in the APC model **120** in some embodiments.

FIGS. **2**A-**2**D show factors in the inter-field model. These factors are uniformly applied within a field, and result in a deviation between a location in one field and the corresponding location in an adjacent field. FIG. **2**A shows inter-field X and Y direction translations T_X and T_Y, respectively. FIG. **2**B shows inter-field wafer rotation R_W. FIG. **2**C shows non-orthogonality (whereby a right angle in one field is transformed into an acute or obtuse angle in another field) FIG. **2**D shows scaling coefficients S_X and S_Y, respectively (which result in one field or shot being elongated or compressed in X and/or Y directions relative to an adjacent field or shot).

In some embodiments, the Inter-field Model is given by:

$$d_x=T_X-(R_W+N)*Y+S_x*X+\text{higher order terms} \tag{1}$$

$$d_y=T_Y+R_w*X+S_Y*Y+\textit{higher order terms} \tag{2}$$

wherein

(X,Y) are inter-field coordinate system, with respect to the center of the wafer,

d_x, d_y are inter-field overlay errors,

T_X, T_Y are inter-field translations,

R_W is wafer rotation,

N is non-orthogonality and

S_X, S_Y are wafer scaling coefficients, and

The higher order terms can be ignored.

FIGS. **2**E-**2**H show factors in the intra-field model. FIG. **2**E shows a symmetric rotation. FIG. **2**F shows an asymmetric rotation. FIG. **2**G shows a symmetrical magnification. FIG. **2**H shows an asymmetrical magnification.

In some embodiments, the intra-field model is given by:

$$d_x=T_x-(R_S+R_A)*y+(M_S+M_A)*x+\text{higher order terms} \tag{3}$$

$$d_y=T_Y+(R_S-R_A)*x+(M_S-M_A)*y+\text{higher order terms} \tag{4}$$

where:

(x,y) is the intra-field coordinate system, with respect to the center of a field,

d_x,d_y are intra-field overlay errors,

T_x, T_y are intra-field translations,

R_S, R_A are symmetrical and asymmetrical field rotations, and

M_S, M_A are symmetrical and asymmetrical field magnifications.

FIG. **3** is a schematic functional diagram of the control apparatus **100**.

Wafers **112** in the first processing group (e.g., wafers which have not undergone a CMP rework process) are exposed in the scanner **104** using scanner overlay correction **122**.

Wafers **114** in the second processing group (e.g., wafers which have undergone a CMP rework process) are also exposed in the scanner **104** using scanner overlay correction **122**. However, an additional adjustment is made to the scanner to compensate for the effect of the rework.

Although FIG. **3** conceptually shows separate processing of the first group **112** and second group **114** of substrates, both groups can be processed in the same scanner **104**. In some embodiments, all of the first group **112** of substrates are exposed in a first batch, and then all of the second group **114** of substrates are exposed in a second batch. In other embodiments, the two groups **112** and **114** of substrates can be intermingled.

FIGS. **5** and **6** show an example of the impact of the mean correction. In both FIG. **5** and FIG. **6**, the Y (vertical) axis represents the overlay error, and the various X (horizontal) axis locations represent different data points corresponding to wafers processed in time sequence. In this example, the overlay error (Y axis) corresponds to error in Sx, the wafer scaling coefficient in the X direction.

In FIG. **5**, the values of one of the above listed exposure parameters for the first group **112** of wafers is represented by circles, and corresponding values for the second group **114** of wafers is represented by diamonds. The mean **502** of the overlay errors for the second (reworked) group is substantially greater than the mean **504** of the overlay errors for the first (non-reworked) group.

In some embodiments, for a CMP rework operation, the deviations in the overlay error correspond to a shift in the mean wafer scaling coefficients S_X, S_Y. Thus, in controlling the operation of the scanner **104**, the values of S_X and S_Y are adjusted by the mean value observed among reworked wafers during the previous rework operations, so as to compensate for the rework-effect when exposing a new plurality of reworked wafers **114** in the scanner **104**.

In FIG. **6**, a mean shift (corresponding to the difference in the means of an exposure parameter between the non-reworked and reworked substrates) is added to the scanner overlay correction model for the reworked substrates. For example, in some embodiments, a mean shift is added to the S_X and S_Y terms of equations (1) and (2), above for each of the reworked wafers. As a result, the difference in overlay error between the non-reworked and pre-processed (e.g., reworked) substrates is effectively eliminated.

In other embodiments, for which the model of equations (1) to (4) apply, other combinations of one or more of the parameters T_X, T_Y, R_W, N, S_X and S_Y of the inter-field model or T_x, T_y, R_S, R_A, M_S, and M_A of the intra-field model are adjusted according to respective differences between the respective means of the non-reworked wafers and the means of the reworked wafers. In other embodiments, the scanner

104 operates according to different scanner overlay control error models, and an appropriate mean shift is implemented.

Although an example above assigns substrates to groups according to whether or not the wafer has undergone CMP rework, the method can be applied for other groupings. For example, in some embodiments, the first group of substrates have not undergone photo rework, and the second group of substrates have undergone photo rework. In other embodiments, the first group and second group differ from each other with respect to whether a processing step (other than rework) is performed prior to exposing the substrate in the scanner **104**.

FIG. **4** is a flow chart of an exemplary process.

In step **400**, a plurality of semiconductor substrates that have been processed by a semiconductor fabrication process are provided for exposure by a stepper, such as a scanner.

At step **402**, the substrates are divided or assigned according to whether the substrates have received special processing. For example, in some embodiments, the substrates are divided into a group that has been reworked (e.g., CMP rework or photo rework), and a group that has not been reworked. The non-reworked substrates are assigned to a first plurality of semiconductor substrates that have not been processed by the semiconductor fabrication process and a rework process. The reworked substrates are assigned to a second plurality of semiconductor substrates that have been processed by the semiconductor fabrication process and a rework process.

At step **404**, a respective mean exposure parameter (e.g., a scaling coefficient S_X, S_X) is computed for each individual one of the first and second subsets.

At step **406**, a mean correction value **108** is computed for each of the exposure parameters that is substantially affected by the differential processing. For example, in some embodiments where the second group of substrates is subjected to an additional step or process that changes a thickness of a layer of the substrate, the scaling coefficients S_X, S_Y are affected. Thus, an X mean shift is computed by subtracting the mean S_X of the substrates in the second group from the mean S_X in the first group. Similarly, the Y mean shift is computed by subtracting the mean S_Y of the substrates in the second group from the mean S_Y in the first group. This is just one example. If the first and second groups differ by a different process or step (other than CMP rework) that affects the second group but not the first, then the mean shift of one or more different parameters of the model are computed.

At step **408**, the mean correction value(s) **108** is (are) stored in a non-transitory, machine readable storage medium, for subsequent use. In some embodiments, this stored value **108** is automatically forwarded to the controller **100**. In other embodiments, a user reads the correction value **108** from the medium **106** and manually enters the value **108** in the controller.

At step **410**, a plurality of substrates are processed by a process or step that is performed prior to an exposure step on the scanner **104**. In some embodiments, this is the same set of substrates processed in step **400** (and used to compute the mean correction in step **406**), but the correction is to be applied to a different layer than the layer processed in step **400**. In some embodiments, the substrates processed in step **410** are not the same substrates processed in step **400**, but the exposure process in the scanner is controlled using the mean correction computed in step **406** (based on the empirical data fed back from the processing in step **400**). For example, the additional wafers can include a third plurality of substrates, on which a rework process has not been performed, and a fourth plurality of substrates, on which a rework process has been performed.

At step **412**, a determination is made whether the substrate to be processed is reworked or not reworked. In some embodiments, this determination is made on a group by group basis. In other embodiments, this determination is made on an individual substrate basis. If the substrate(s) to be processed are not reworked, step **414** is performed next. If the substrate(s) to be processed are reworked, step **416** is performed next.

At step **414**, a first scanner overlay correction is applied to the scanner for exposing the first plurality of (non-reworked) substrates. Then step **420** is performed next.

At step **416**, a second scanner overlay correction is applied to the scanner for exposing the second plurality of (reworked) substrates. In some embodiments, the first and second scanner overlay corrections are the same as each other.

At step **418**, the mean correction value **108** stored in the storage medium **106** is applied to the scanner for exposing the second plurality of substrates.

At step **420**, the scanner exposes the substrate(s) using the applied settings. Thus, for example, a new (third) plurality of substrates, on which the rework process has not been performed, can be exposed, without using the mean correction **108**. Meanwhile, a new (fourth) plurality of substrates, on which the rework process has been performed, can be exposed, using the mean correction **108**.

As described herein, the pre-processing effects of rework, film thickness, range and out-of-specification values can be eliminated by the combination of overlay APC with scanner overlay correction and mean shift correction. When the mean shift is added to the overlay APC for reworked substrates, these pre-processing effects are reduced or eliminated. Based on simulations, the standard deviation of overlay errors can be reduced by about 14 to 18% by using the mean correction for reworked substrates.

In some embodiments, a method comprises: (a) providing a first plurality of semiconductor substrates that have been processed by a semiconductor fabrication process; (b) providing a second plurality of semiconductor substrates that have been processed by the semiconductor fabrication process and a rework process; (c) applying a first scanner overlay correction to expose the first plurality of substrates; and (d) applying a second scanner overlay correction and a mean correction to expose the second plurality of substrates.

In some embodiments, a method comprises: (a) performing a semiconductor fabrication process on a plurality of substrates; (b) after step (a), dividing the plurality of substrates into a first subset and a second subset; (c) performing a rework process on the second subset of the plurality of substrates but not on the first subset; (d) computing a respective mean value of at least one exposure parameter for a lithography process for each respective one of the first and second subsets of the plurality of substrates; and (e) applying a scanner overlay correction and a mean correction to expose a second plurality of substrates on which the rework process has been performed, the mean correction being based on the mean values from step (d).

In some embodiments, control apparatus comprises: a controller configured to determine whether a semiconductor substrate to be exposed by a scanner has been subjected to a rework process. A non-transitory, machine readable storage medium contains a mean correction value to be applied to the scanner for exposing the semiconductor substrate if the semiconductor substrate has been subjected to the rework process. The controller is configured to control the scanner using a scanner overlay correction. The controller is further configured to apply the mean correction value to adjust an exposure parameter of the scanner if the semiconductor substrate to be exposed by the scanner has been subjected to the rework process.

The methods and system described herein may be at least partially embodied in the form of computer-implemented processes and apparatus for practicing those processes. The disclosed methods may also be at least partially embodied in the form of tangible, non-transient machine readable storage media encoded with computer program code. The media may include, for example, RAMs, ROMs, CD-ROMs, DVD-ROMs, BD-ROMs, hard disk drives, flash memories, or any other non-transient machine-readable storage medium, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the method. The methods may also be at least partially embodied in the form of a computer into which computer program code is loaded and/or executed, such that, the computer becomes a special purpose computer for practicing the methods. When implemented on a general-purpose processor, the computer program code segments configure the processor to create specific logic circuits. The methods may alternatively be at least partially embodied in a digital signal processor formed of application specific integrated circuits for performing the methods.

Although the subject matter has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be construed broadly, to include other variants and embodiments, which may be made by those skilled in the art.

What is claimed is:

1. A control apparatus comprising:

a controller configured to determine whether a semiconductor substrate to be exposed by a scanner has been subjected to a rework process; and

a non-transitory, machine readable storage medium containing a mean correction value to be applied to the scanner for exposing the semiconductor substrate if the semiconductor substrate has been subjected to the rework process, wherein:

the controller is configured to control the scanner using a scanner overlay correction, and

the controller is further configured to apply the mean correction value to adjust an exposure parameter of the scanner if the semiconductor substrate to be exposed by the scanner has been subjected to the rework process.

2. The apparatus of claim **1**, wherein the controller is configured to control the scanner to expose substrates, on which the rework process has not been performed, without using the mean correction.

3. The apparatus of claim **1**, wherein the controller is configured to compute the mean correction as a difference between:

a mean of the exposure parameter among a first plurality of substrates that have been processed by the semiconductor fabrication process and the rework process, and

a mean of the exposure parameter among a second plurality of substrates that have been processed by the semiconductor fabrication process but not the rework process.

4. The apparatus of claim **3**, wherein the exposure parameter includes:

a first wafer scaling coefficient for a first direction; and

a second wafer scaling coefficient for a second direction orthogonal to the first direction.

5. The apparatus of claim **1**, wherein the semiconductor fabrication process is a chemical mechanical polishing (CMP) process performed on a layer of one of the first plurality of substrates, and the rework process is a CMP rework process performed on the same layer of the one substrate.

6. The apparatus of claim **1**, wherein the exposure parameter is one of the group consisting of wafer rotation, wafer non-orthogonality and wafer scaling coefficients.

7. The apparatus of claim **1**, wherein the controller contains an overlay advanced process control model corresponding to the scanner, the model including an adjustment for wafer rotation, an adjustment for wafer non-orthogonality and an adjustment for wafer scaling coefficients.

8. The apparatus of claim **1**, wherein:

the controller is configured to compute the mean correction as a difference between:

a mean of the exposure parameter among a first plurality of substrates that have been processed by the semiconductor fabrication process and the rework process, and

a mean of the exposure parameter among a second plurality of substrates that have been processed by the semiconductor fabrication process but not the rework process;

the controller is configured to control the scanner to expose substrates, on which the rework process has not been performed, without using the mean correction;

the exposure parameter includes:

a first wafer scaling coefficient for a first direction; and

a second wafer scaling coefficient for a second direction orthogonal to the first direction;

the semiconductor fabrication process is a chemical mechanical polishing (CMP) process performed on a layer of one of the first plurality of substrates, and the rework process is a CMP rework process performed on the same layer of the one substrate; and

the controller contains an overlay advanced process control model corresponding to the scanner, the model including an adjustment for wafer rotation, an adjustment for wafer non-orthogonality and an adjustment for wafer scaling coefficients.

9. The apparatus of claim **1**, wherein the semiconductor fabrication process is a photo process performed on a layer of one of the first plurality of substrates, and the rework process is a photo rework process performed on the same layer of the one substrate.

10. A control apparatus comprising:

a controller configured to determine whether a semiconductor substrate to be exposed by a scanner has been subjected to a first set of fabrication processes; and

a non-transitory, machine readable storage medium containing a mean correction value to be applied to the scanner for exposing the semiconductor substrate if the semiconductor substrate has been subjected to a second set of fabrication processes different from the first set of fabrication processes, wherein:

the controller is configured to control the scanner using a scanner overlay correction, wherein:

the controller is further configured to apply the mean correction value to adjust an exposure parameter of the scanner if the semiconductor substrate to be exposed by the scanner has been subjected to the second set of fabrication processes, and

the controller is configured to control the scanner to expose substrates subjected to the first set of fabrication processes, without using the mean correction.

11. The apparatus of claim **10**, wherein the controller is configured to compute the mean correction as a difference between:

a mean of the exposure parameter among a first plurality of substrates that have been processed by the second set of fabrication processes, and a mean of the exposure parameter among a second plurality of substrates that have been processed by the first set of fabrication processes.

12. The apparatus of claim **11**, wherein the exposure parameter includes:

a first wafer scaling coefficient for a first direction; and

a second wafer scaling coefficient for a second direction orthogonal to the first direction.

13. The apparatus of claim **10**, wherein the second set of fabrication processes includes a chemical mechanical polishing (CMP) process performed on a layer of one of the first plurality of substrates, and a CMP rework process performed on the same layer of the one substrate.

14. The apparatus of claim **10**, wherein the exposure parameter includes:

a first wafer scaling coefficient for a first direction; and

a second wafer scaling coefficient for a second direction orthogonal to the first direction.

15. The apparatus of claim **10**, wherein the exposure parameter is one of the group consisting of wafer rotation, wafer non-orthogonality and wafer scaling coefficients.

16. The apparatus of claim **10**, wherein the controller contains an overlay advanced process control model corresponding to the scanner, the model including an adjustment for wafer rotation, an adjustment for wafer non-orthogonality and an adjustment for wafer scaling coefficients.

17. Apparatus comprising:

a scanner; and

a controller for controlling operation of the scanner, the controller configured to determine whether a semiconductor substrate to be exposed by the scanner has been subjected to a rework process; and

a non-transitory, machine readable storage medium containing a mean correction value to be applied to the scanner for exposing the semiconductor substrate if the semiconductor substrate has been subjected to the rework process, wherein:

the controller is configured to control the scanner using a scanner overlay correction, and

the controller is further configured to apply the mean correction value to adjust an exposure parameter of the scanner if the semiconductor substrate to be exposed by the scanner has been subjected to the rework process.

18. The apparatus of claim **17**, wherein the controller is configured to compute the mean correction as a difference between:

a mean of the exposure parameter among a first plurality of substrates that have been processed by the semiconductor fabrication process and the rework process, and

a mean of the exposure parameter among a second plurality of substrates that have been processed by the semiconductor fabrication process but not the rework process.

19. The apparatus of claim **18**, wherein the exposure parameter includes:

a first wafer scaling coefficient for a first direction; and

a second wafer scaling coefficient for a second direction orthogonal to the first direction.

20. The apparatus of claim **17**, wherein the exposure parameter is one of the group consisting of wafer rotation, wafer non-orthogonality and wafer scaling coefficients.

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